usually only minor constituents of the aeolianite, but in some bands within the fossil dunes they reach a high concentration.

An emerged coral reef in Salmon Bay, lithified shell deposits at Geordie Bay, and the shell beds around the margins of the salt lakes represent marine incursions into the "Coastal Limestone" during periods of higher sea-level. The fossil soils are characterised by their massive structure and the presence of the terrestrial gastropod *Bothriembryon*. They formed fairly rapidly in flat interdunal areas and do not exhibit signs of soil maturity.

Soils forming at the present time are shallow and immature. They show the initial stage in soil formation, namely the accumulation of organic matter near the surface.

Physiography

Rottnest Island is characterized by rolling sand dune topography, and reaches a maximum elevation of only 154 feet. Permanent drainage channels are absent, but a number of swamps form in favourable interdune locations during winter (see p. 85 herein). The system of salt lakes represents shallow arms of the sea which were isolated in recent times, by bar and dune formation near the present coast.

A striking physiographic feature of the Island is the ubiquitous occurrence of narrow marine benches situated a few feet above mean-sea-level along the present coastline and around the margins of the salt lakes. Previous authors (Teichert 1950; Fairbridge 1954) have interpreted these features as remnants of low-water-level marine benches formed during recent eustatic still-stands or slow retreat of sea-level. Benches at 10-11 feet above the present mean-sea-level have been related to the "Flandrian" sea-level of Europe, those at 5-6 feet to the "Calaisian" and those at 2-3 feet to the "Dunkirkian." Emerged coral reefs at Salmon Bay and Stark Bay and shell beds around the lakes yield unmistakable evidence of higher sea-levels. However, studies in progress suggest at least some of the low-water-level benches formed during these periods of higher sea-level have been either drastically remodelled or obliterated by rapid erosion. Some of the benches around the present coastline appear to owe their form to surface induration of the aeolianite near the upper limit of the splash zone, and it therefore seems that they are unrelated to eustatic phenomena.

A fall in present sea-level of approximately five fathoms would link Rottnest Island to the mainland as a peninsula extending through Garden Island to Point Peron. Fossil pollen and radiocarbon studies (Churchill 1959) indicate that, approximately 5,000 years B.C., sea-level stood five fathoms lower than at present. The separation of Rottnest as an island is thus a young geological event.

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13.—The Vegetation of Rottnest Island

Our earliest record of the vegetation of what is now Rottnest Island comes from fossil pollen and megascopic remains in swamp sediments and dunes of late Pleistocene age. Apart from species still found on the Island, the past occurrence of *Eucalyptus gomphocephala*, *E. marginata*, *E. ealophylla*, *Agonis*, *Casuarina*, *Banksia*, *Macrozamia* and *Xanthorrhoea* indicates that a tuart woodland similar to that of the present mainland once existed here. Since then, rising sea-level and erosion have reduced the area to an island, 7 miles long and 3 miles wide. Consequent increase in wind exposure and deterioration in rainfall have played their part in rendering former habitats unsuitable for tuart woodland. Thus the present vegetation consists solely of elements of a *coastal complex*.

Supralittoral Vegetation

In comparison with the mainland, the strand plants *Cakile maritima* and *Arctotheca nivea*, and the fore-dune species *Spinifex hirsutus* and *Tetragonia zeyheri*, are rare on the island. The dominant plant of Rottnest fore-dunes is *Spinifex longifolius;* associated with it are *Atriplex isatidea* and the introduced *Anthericum divaricatum*.

An entirely different suite (mostly of succulents) occupies rocky shores: *Carpobrotus aequilaterus*, *Threlkeldia diffusa*, *Tetragonia implexicoma*, *Sporobolus virginicus*, *Eremophila glabra*, *Nitraria schoberi*, *Enchylaena tomentosa*, *Arthrocnemum halocnemoides*, *Salicornia australis* and *Atriplex paludosa*. Many of these species are now abundant only on offshore stacks and islets. Except at Cape Vlaming, excessive browsing by quokkas in summer has exterminated or impoverished most of the succulent-dominated communities on the main island coast.

Coastal Dune Vegetation

This is a fairly open formation of low, generally microphyllous, shrubs, 1 to 5 feet high. Composition and height depend on wind exposure and depth of sand over the consolidated dune. The succession from sandy shores is usually

through *Scirpus nodosus*, *Scaevola crassifolia* and *Calocephalus brownii* to *Olcaria axillaris*. The stony phase is pioneered by the dwarf shrub *Frankenia pauciflora*, which, with decreasing exposure, is replaced by taller shrubs; *Westringia dampieri*, *Leucopogon insularis*, *L. parviflorus*, *Acrotriche cordata* and *Boronia alata*. On leeward slopes most of these give way to *Acacia cuneata*, *Olearia axillaris*, *Myoporum insulare*, *Diplolaena dampieri*, *Melaleuca pubescens*, and *Acacia rostellifera*.

Interdunal Vegetation

In sheltered valleys and slopes, where the sand is deep and the accretion of silt has enhanced its water holding capacity, a scrub develops, almost exclusively of *Acacia rostellifera*. Typically the formation is closed and from 10-20 feet in height. The liana *Clematis microphylla* is common here. Undergrowth is sparse and usually restricted to *Stipa variabilis* and *Acanthocarpus preissii*.

This scrub was once far more extensive than it is at present. As recently as the end of last century, visitors could describe the vegetation of Rottnest as "impenetrable" beyond the confines of the eastern settlement. Today all that remains of the scrub in the western half of the island are a few isolated thickets of *Acacia rostellifera*.

Where the scrub has gone, there now occurs a low dense formation consisting almost exclusively of sclerophyllous monocotyledonous plants. The most characteristic species is *Acanthocarpus preissii*, a fruticose, pungent-leaved perennial, 1-3 feet high. It is usually associated with a tussock grass, *Stipa variabilis*. Less common are two other tussock grasses *Poa australis* and *Danthonia caespitosa*, the sword rushes *Lepidosperma gladiatum* and *L. resinosum*, *Conostylis candicans* and a small grass-like sedge, *Carex preissii*. Apart from annuals, dicotyledonous species are uncommon and are usually found (1) in disturbed areas (e.g. *Thomasia cognata*), (2) where the scrub has recently disappeared (e.g. *Didiscus caeruleus* and *Guichenotia ledifolia*), or (3) where the limestone is near the surface (e.g. *Stackhousia pubescens* and *Oxalis corniculata*).

Recent research has shown that the status of the *Acacia* depends on quokka grazing pressure. Where the animals are abundant, the *Acacia* is eaten out and replaced by communities of herbs and low shrubs that are resistant to fire and generally unpalatable to quokkas. Where quokkas are excluded by fences or where their density is low, as in the Stark Bay hinterland, *Acacia* thickets expand into the surrounding *Acanthocarpus-Stipa*.

Thus *Acanthocarpus-Stipa* and *Acacia* scrub are the end-points of a single sere, whose direction is controlled by the intensity of quokka grazing. The present trend over most of the Island is for *Acanthocarpus* to replace scrub, which implies a recent increase in the abundance of the quokkas. The evidence for such an increase and the factors responsible for it, have been discussed by Storr (1957).

Limestone Ridge Vegetation

In the western two-thirds of the Island, the consolidated dunes are usually covered by shallow calcareous sands. At the eastern end of the Island the dunes are frequently covered by finer sands relatively rich in organic matter, which support a closed formation comprising several species of shrubs 5-15 feet high. *Templetonia retusa* occasionally occurs in pure stands. More often it is mixed with one or more of the following: *Pittosporum phillyrioides*, *Spyridium globulosum*, *Beyeria viscosa*, *Alyxia buxifolia*, *Acacia rostellifera* and *Melaleuca pubescens*. Most of these species reappear on limestone cliffs in sheltered bays. Undergrowth is sparse and confined usually to *Phyllanthus calycinus*, *Acanthocarpus preissii*, *Stipa variabilis* and *Guichenotia ledifolia*.

Swamp and Salt-lake Vegetation

The various marsh communities form concentric zones around the lakes and swamps. Except where the limestone is bare, the innermost zone is dominated by the samphires, *Arthrocnemum arbuscula*, *A. halocnemoides*, and *Salicornia australis*. During winter and spring this zone is largely under water. In early summer after the water has receded, certain low creeping perennials renew their growth, viz.; *Hemichroa pentandra*, *Wilsonia humilis*, *Samolus repens* and *Suaeda australis*.

The next zone is dominated by the large tussocky sedge, *Gahnia trifida*. Sometimes it is mixed with or replaced by the erect sedges and rushes, *Scirpus nodosus*, *Hypolaena* sp. and *Juncus maritimus*. Less frequently it is interspersed with bushes of *Arthrocnemum halocnemoides*, *Atriplex paludosa* or *Myoporum viscosum*. Wherever the soil is less saline and richer in organic matter, a mat of grasses and herbs covers the bare spaces between tussocks of *Gahnia*. The mat is dominated by the perennial grass *Sporobolus virginicus*.

As the land rises, the *Gahnia* is replaced by *Melaleuca pubescens*, an erect or umbrageous tree up to 40 feet high. It forms the only dominant of a closed community in which undergrowth is rare apart from the ascending succulent, *Threlkeldia diffusa*, and occasional tussocks of *Stipa variabilis*. If the flats surrounding the lake are extensive there is a correspondingly broad zone of *Melaleuca pubescens*, but where the land continues to rise it gives way to *Acacia rostellifera* or *Pittosporum phillyrioides* according as the soil is deep or shallow over the limestone.

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